IN THE OFFICE OF THE STATE ENGINEER
OF THE STATE OF NEVADA

ORDER **#1331**

ESTABLISHING THE PERENNIAL YIELD FOR THE DRY VALLEY HYDROGRAPHIC BASIN (095) WITHIN WASHOE COUNTY, NEVADA

I. AUTHORITY AND NECESSITY

WHEREAS, the State Engineer is designated by the Nevada Legislature to perform the duties related to the management of the water resources belonging to the people of the State of Nevada.[1]

WHEREAS, the State Engineer is empowered to make such reasonable rules and regulations as may be necessary for the proper and orderly execution of the powers conferred by law.[2]

WHEREAS, for each administratively delineated hydrographic basin located in whole or in part in the State, the State Engineer shall prepare a water budget and calculate and maintain an inventory of water, which includes an estimate of the amount of all groundwater that is available for appropriation in the basin.[3]

WHEREAS, the State Engineer is encouraged to consider the best available science in rendering decisions concerning the availability of surface and underground sources of water in Nevada.[4]

WHEREAS, current commitments in the Dry Valley basin for both groundwater and surface water total 25.6 acre-feet and 5,472.1 acre-feet, respectively, of permitted, certificated and vested water rights, with a portion of these rights being supplemental to each other.[5] An additional 20 acre-feet of groundwater is committed for domestic use.[6] There are applications to appropriate

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[1] NRS 232.100(2); NRS Title 48.
[2] NRS 532.120.
[3] NRS 532.167(3).
[4] NRS 533.024(1)(c).
[5] Nevada Division of Water Resources' Water Rights Database, Hydrographic Abstract, Dry Valley Hydrographic Basin (95), accessed August 5, 2022, official records in the Division of Water Resources, available at *http://water.nv.gov/HydrographicAbstract.aspx*
[6] Nevada Division of Water Resources' Water Rights Database, Underground Active-Groundwater Commitments and Availability, Dry Valley Hydrographic Basin (095), accessed August 4, 2022, official records in the Division of Water Resources, available at *http://water.nv.gov/undergroundactive.aspx*

groundwater pending before the State Engineer seeking to appropriate an additional 9,400 acre-feet annually.[7]

WHEREAS, in 1971 the perennial yield of Dry Valley was estimated to be 1,000 acre-feet.[8] In 2002, based on information and an analysis presented at that time, Permits 64977, 64978, and 66400 were issued for 2,996 acre-feet annually.[9,10] While the perennial yield shown on the Division of Water Resources' website is 3,000 acre-feet, studies completed since 2002 contain findings that are important to better understand perennial yield and available water supply for Dry Valley.

WHEREAS, the State Engineer finds that he has a duty to apply the best available science to inform decisions and to ensure the best management practices are applied in a groundwater basin so as to prevent avoidable problems associated with over-appropriation and overuse of the groundwater resources. This duty extends to actions and decisions in the Dry Valley Hydrographic Basin required to fulfill the State Engineer's statutory responsibilities to support current and future uses for innumerable years to come.

WHEREAS, Dry Valley spans the border between Nevada and California.[11] California's Sustainable Groundwater Management Act, signed into law in 2014, provides a framework for sustainable groundwater management in California.[12] The State Engineer finds that pursuant to the principle of comity, consideration of the effects of groundwater development on existing rights in California is appropriate, even if not statutorily required, and to do so will aid in promoting harmony and building goodwill between the states.

WHEREAS, the State Engineer has the authority to hold a hearing to take evidence and hear testimony on the interpretation of the evidence with respect to his responsibility to manage Nevada's water resources.[13]

WHEREAS, on October 7, 2020, the State Engineer issued Order 1316 giving notice of the State Engineer's investigation to consider the perennial yield of the Dry Valley Hydrographic

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[7] Nevada Division of Water Resources' Water Rights Database, Hydrographic Abstract, Dry Valley Hydrographic Basin (95), accessed August 5, 2022, official records in the Division of Water Resources, available at *http://water.nv.gov/HydrographicAbstract.aspx*

[8] State Engineer (NSE) Ex. No. 7, hearing on Order 1316, official records in the Division of Water Resources.

[9] The perennial yield of the basin was revised to reflect these findings.

[10] Permits 64977, 64978, and 66400 were cancelled in 2018; however, these permits remain subject to ongoing administrative proceedings before the State Engineer.

[11] NSE Ex. No. 2, p. 3, hearing on Order 1316, official records in the Division of Water Resources.

[12] *See* "Sustainable Groundwater Management Act (SGMA)" at the California Department of Water Resources, https://water.ca.gov/programs/groundwater-management/sgma-groundwater-management (last accessed January 3, 2022).

[13] NRS 532.110.

Basin.[14] The public was invited to file a report with the Office of the State Engineer providing an evaluation of the existing studies and literature available with regards to the perennial yield of the Dry Valley Hydrographic Basin, within the Nevada portion.[15] Sierra Pacific Industries (SPI) and IWS Basin, LLC (IWS) filed reports in response to the Order 1316 solicitation. Buckhorn Land and Livestock, LLC's attorney filed a notice to appear the day prior to the hearing.[16]

WHEREAS, a public hearing was held on January 20, 2021, via video and teleconference.[17] The purposes of this hearing were to afford participants who submitted reports pursuant to Order 1316 an opportunity to provide testimony to the State Engineer on their evaluation of existing studies and literature regarding the perennial yield of the hydrographic basin, and to test the evaluation and recommendations offered by other participants.

WHEREAS, during the Order 1316 hearing, testimony was provided by witnesses on behalf of SPI and IWS. The submission from IWS was limited to information described in Order 1316.[18] After comparing and critically reviewing the various investigations identified by the State Engineer, IWS concluded that the perennial yield of Dry Valley should be 2,200 acre-feet. SPI undertook the development of a revised hydrogeologic conceptual model that recalculated the water budget and used methodologies that varied from existing investigations.[19] Results from the revised model and analysis concluded that the system yield of Dry Valley was 2,911 acre-feet annually. Following the conclusion of the hearing, the State Engineer opened a public comment period allowing any interested person until January 22, 2021, to provide comment regarding the subject matter of the hearing. Buckhorn Land and Livestock, LLC provided public comment. Buckhorn Land and Livestock supported a long-term pumping test to better test the data and assumptions contained in the various reports.[20]

WHEREAS, the State Engineer directed the technical staff of the Division of Water Resources to review and evaluate the already existing body of research, in addition to the evidence and testimony provided by the participants as it pertained to the understanding of the perennial yield in Dry Valley and the calculation of water available for appropriation. The result of that technical review and analysis is documented in the "Evaluation of Best Estimates of Water Budget Components and Recommended Perennial Yield for the Dry Valley Hydrographic Basin (HA095)."[21]

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[14] State Engineer's Order 1316, dated Oct. 7, 2020, official records in the Division of Water Resources.
[15] *Id.,* pp. 1, 9.
[16] Exhibits for Hearing on Order 1316, official records in the Division of Water Resources.
[17] Transcript of proceedings, official records in the Division of Water Resources.
[18] IWS Ex. No. 1, hearing on Order 1316, official records in the Division of Water Resources.
[19] SPI Ex. No. 1, hearing on Order 1316, official records in the Division of Water Resources.
[20] Letter dated January 22, 2021, "Buckhorn Land & Livestock, LLC Comments in Response to Order 1316," official records in the Division of Water Resources.
[21] "Technical Memorandum," available in the official records in the Division of Water Resources.

II. CALCULATION OF PERENNIAL YIELD

WHEREAS, the perennial yield of a groundwater reservoir may be defined as the maximum amount of groundwater that can be withdrawn each year over the long term without depleting the groundwater reservoir. Perennial yield is ultimately limited to the maximum amount of natural discharge that can be utilized for beneficial use. The perennial yield cannot be more than the natural recharge to a groundwater basin and in some cases is less.

WHEREAS, to determine the amount of groundwater available for withdrawal, the State Engineer must determine the water budget of a groundwater basin or an interconnected source of water.[22] The groundwater budget of an aquifer is an accounting of the rates or amounts of water that move into and out of the saturated system. Inflow, or recharge, is the precipitation or surface runoff that infiltrates into the subsurface and percolates to the saturated zone. Outflow, or discharge, is the water that flows out of the aquifer as evapotranspiration or as spring discharge and stream baseflow. In some settings, groundwater may also flow between aquifers or administratively defined hydrographic basins. In a natural system, where climatic conditions are reasonably stable, the long-term mean annual recharge and discharge of an aquifer are equal.[23] However, recharge and discharge estimates can be made independently using different methods and often do not match. Discharge is generally a more reliable measure of the groundwater budget than recharge because discharge can commonly be observed and measured where it occurs.

WHEREAS, in considering the perennial yield of the Dry Valley Hydrographic Basin, water budget components including precipitation, recharge, discharge and subsurface outflow are discussed below. For each component, the State Engineer considered the existing estimates and their corresponding methodologies; the testimony from participants' witnesses regarding those existing estimates and the witnesses' opinions of the best estimate value; and then an independent technical finding made by the Nevada Division of Water Resources technical staff about which value is the most accurate considering the methods of analysis and the level of uncertainty.

A. PRECIPITATION

WHEREAS, existing estimates of average annual precipitation for Dry Valley range from 44,000 to 80,000 acre-feet.[24] Calculations using the Parameter-Elevation Regressions on Independent Slopes Model (PRISM), which use more recent data and more regional gage measurements than earlier methods, result in substantially higher estimates of precipitation for Dry Valley.[25] However, examination of actual precipitation measurements in and adjacent to the Dry Valley area, in conjunction with PRISM, supports the conclusion that PRISM overestimates precipitation in Dry Valley, and that values determined from a combination of PRISM and local

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[22] *See, e.g.*, NRS 533.024(1)(e).
[23] Office of the State Engineer, *Water for Nevada, State of Nevada Water Planning Report No. 3,* p. 12, Oct. 1971.
[24] The lower value was calculated using an iso-contour map by Rush and Glancy in the 1960s, and the higher value was calculated using PRISM in 2000 and 2003. *See* NSE Ex. Nos. 7, 8, and 9, hearing on Order 1316, official records in the Division of Water Resources.
[25] Technical Memorandum.

precipitation observations, which are in the range of 60,000 to 66,000 acre-feet, are more reliable.[26] The State Engineer has considered the precipitation estimates discussed by the witnesses and finds that the more accurate methodology to estimate precipitation uses both PRISM and local precipitation measurements. The State Engineer finds that an average annual value of 60,000 acre-feet in the upland recharge areas, and 63,000 acre-feet for the entire basin, is the best estimate of precipitation in Dry Valley.

B. RECHARGE

WHEREAS, participants in the hearing presented evidence and testimony regarding the portion of recharge occurring in the uplands and the portion of recharge occurring lower in the basin from runoff. Methods that have been used to estimate groundwater recharge in Dry Valley are commonly considered to be "reconnaissance-level" values because they either rely on relationships found in other basins or they do not directly measure recharge occurring within the basin of concern.[27] One method, using a chloride mass-balance technique, relies on actual measurements of chloride in water to determine the portion of precipitation that becomes part of the groundwater system, but this is also considered to provide reconnaissance-level estimates due to limitations on the underlying assumptions, including accuracy of precipitation estimates, and the representative nature of limited measured chloride values in a recharge area.[28]

WHEREAS, existing estimates of average annual recharge for Dry Valley range from 1,400 to greater than 11,000 acre-feet.[29] Witness reports provided two estimates at the far ends of the range: 2,950 acre-feet using a method based on chloride measurements and an updated precipitation model, and 8,280 acre-feet calculated using the empirical water yield-runoff method.[30] Both of these are reconnaissance-level methods. The State Engineer finds that the 2,950 acre-feet estimate of average annual groundwater recharge is the most reasonable value because it is made in the context of other peer-reviewed estimates in literature, and the proportion of precipitation that becomes recharge is in the range of 2-5% which is commonly observed in basins throughout Nevada.[31]

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[26] IWS Ex. No. 3, hearing on Order 1316, official records in the Division of Water Resources; NSE Ex. Nos. 9, 10, hearing on Order 1316, official records in the Division of Water Resources.
[27] Technical Memorandum.
[28] Mizell, S.A., Russell, C.E., and Kluesner, T.L., 2007, Reconnaissance estimation of groundwater recharge to selected hydrographic basins of eastern Nevada and western Utah using the chloride mass-balance method: University of Nevada, Desert Research Institute Publication 41232, 35 p. *and* Dettinger, M.D., 1989, Reconnaissance estimates of natural recharge to desert basins in Nevada, U.S.A., by using chloride-balance calculations: Journal of Hydrology, v. 106, p. 55-78.
[29] Technical Memorandum; NSE Ex. Nos. 7, 8, 9; IWS Ex. No. 2, hearing on Order 1316, official records in the Division of Water Resources.
[30] SPI Ex. No. 1; IWS Ex. No. 1.
[31] IWS Ex. No. 1, p. 2.

WHEREAS, estimates in the existing literature of annual recharge from runoff in Dry Valley range from 50 to 3,500 acre-feet.[32] One witness report concluded that some unspecified amount of recharge from runoff occurs during normal to wet years. Another witness report determined that 882 acre-feet or 15% of mountain-block runoff is a reasonable estimate of annual recharge from runoff.[33] Considering the analysis and observations of both witnesses, the State Engineer finds that 750 acre-feet is the best estimate of annual groundwater recharge from surface water runoff. This is in addition to the 2,950 acre-feet of average annual groundwater recharge considered to occur in Dry Valley.

C. DISCHARGE

WHEREAS, participants in the hearing presented evidence and testimony estimating different components of groundwater discharge in Dry Valley, including groundwater evapotranspiration on the valley floor, groundwater evapotranspiration in the mountains, subsurface outflow across the Nevada-California state line, and subsurface outflow to adjacent basins in Nevada.

WHEREAS, estimates of annual groundwater evapotranspiration that were published or reported prior to this proceeding range from 80 to about 1,750 acre-feet annually.[34] The two hearing participants presented their recommended estimates of annual groundwater evapotranspiration using different methodologies and different data sets. One estimate was derived by reviewing the scientific analyses previously conducted for Dry Valley and averaging estimates from the three most recent studies performed by Huntington (2010), Beamer et al. (2013), and Minor (2019).[35] All three studies relied upon similar methodologies using Landsat imagery, vegetation indices, and flux towers to estimate groundwater evapotranspiration. The average of the three studies resulted in a value of 1,100 acre-feet of annual groundwater evapotranspiration.[36] The other estimate used a new vegetation study that greatly expanded the extent of the phreatophytic vegetation in Dry Valley and extended the area into the uplands, resulting in a significant increase in the mapped area where groundwater evapotranspiration may be occurring.[37] The annual groundwater evapotranspiration using this method was estimated to be 1,761 acre-feet on the valley floor and 734 acre-feet in the uplands for a total of 2,495 acre-feet.[38] Although this estimate used a similar methodology to estimate groundwater evapotranspiration, the expanded evapotranspiration area used for this estimate is a notable outlier in comparison to other recent studies. The State Engineer finds that there is substantial uncertainty in the newly defined phreatophyte extent created from the vegetation study because of limited verification that the

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[32] Technical Memorandum; IWS Ex. No. 6, hearing on Order 1316, official records in the Division of Water Resources; NSE Ex. Nos. 7, 8; Tr. pp. 150, 162
[33] SPI Ex. No. 1; IWS Ex. No. 1.
[34] Technical Memorandum.
[35] IWS Ex. No. 1; *see also* NSE Ex. Nos. 1, 4, and 6, hearing on Order 1316, official records in the Division of Water Resources.
[36] *Id.*
[37] SPI Ex. No. 1.
[38] *Id.*

vegetation within this expanded area truly has some reliance on groundwater. The State Engineer finds that the value of 1,100 acre-feet is considered the best estimate of average annual groundwater evapotranspiration on the valley floor.

WHEREAS, subsurface outflow of groundwater from Dry Valley through the shallow alluvium is likely to occur at the Nevada-California stateline. Most existing estimates utilize Darcy's Law to determine the subsurface outflow along the state boundary within Dry Valley, which requires an estimate of hydraulic conductivity or transmissivity, the cross-sectional dimensions of the aquifer at the state line, and the hydraulic gradient across the state line.[39] Existing literature provides annual estimates ranging from 50 to 4,500 acre-feet.[40] IWS acknowledged that the methods used by Widmer,[41] who estimated 400 acre-feet of annual outflow were the most reasonable, but recommended a revised estimate of 1,000 acre-feet based on additional flow through deeper portions of the groundwater system. SPI did not specifically evaluate existing estimates for outflow at the state line, but indicated a range between 500 to 1,500 acre-feet.[42] Due to the lack of an evaluation of this component by SPI, and the recommendation by IWS of a new and more speculative amount based on information outside of the existing studies, the State Engineer finds that 400 acre-feet is the best estimate of subsurface outflow at the state line.

WHEREAS, groundwater outflow along structural conduits in the bedrock or deep sediments has been considered or suggested in several existing reports, with amounts ranging from insignificant to thousands of acre-feet.[43] There is large uncertainty and a high divergence of opinion regarding the occurrence of structurally controlled groundwater flow out of Dry Valley and into other Nevada basins such as Warm Springs Valley and Honey Lake Valley or Newcomb Valley. Dry Valley is a headwaters basin that contributes to the water supply for adjacent basins, and each of these potential outflow locations are fully appropriated watersheds reliant on existing subsurface outflow. The State Engineer finds that the current data are inadequate to make an exact conclusion about the best estimate of average annual groundwater outflow discharging from Dry Valley through structural conduits in bedrock or deep sediments.

III. PERENNIAL YIELD

WHEREAS, the State Engineer relies on the perennial yield as the primary guideline to determine water available to appropriate within an administrative groundwater basin. Although groundwater development potential may have additional or different constraints depending on localized hydrogeology or well construction or other statutory limitation pursuant to Nevada Revised Statute (NRS) § 533.370, the perennial yield is a single value that represents the

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[39] NSE Ex. Nos. 2, 7 and 8; NSE Ex. No. 5, hearing on Order 1316, official records in the Division of Water Resources.
[40] *Id.*
[41] SPI Ex. No. 1; IWS Ex. No. 1; NSE Ex. Nos. 4, 10; NSE Ex. No. 11, hearing on Order 1316, official records in the Division of Water Resources
[42] SPI Ex. No. 1.
[43] NSE Ex. Nos. 2, 8; *see also* SPI Ex. No. 1; Buckhorn Land & Livestock public comment; IWS Ex. No. 1.

groundwater budget for the general purpose of determining water availability and whether new appropriations may be granted in accordance with NRS 533.370.

WHEREAS, IWS recommends a perennial yield value of 2,200 acre-feet based on the sum of their best estimate of groundwater evapotranspiration (1,100 acre-feet), outflow from the shallow alluvium at the Nevada-California state line (400 acre-feet), and one-half of the groundwater outflow assumed to flow out of Dry Valley in fractured bedrock or deep sediments (700 acre-feet). SPI recommend a perennial yield in the range of 1,761 to 2,495 acre-feet based on their independent estimates of groundwater evapotranspiration from the valley floor (1,761 acre-feet) and from the uplands (734 acre-feet). SPI also recommends a system yield of 2,055 or 2,911 acre-feet that provides for additional use based on the assumption that a portion of pumped water for irrigation would become return flow and could be re-used. The State Engineer finds that this component of return flow is a non-consumptive use that is typical on irrigated land and is not an additional source of water that is not already accounted for in the water budget.

WHEREAS, the State Engineer finds that based on the consideration of testimony and evidence regarding the accuracy and validity of existing Dry Valley water budget estimates and based upon the State Engineer's own technical analysis of the testimony and evidence presented, the Dry Valley perennial yield is best determined as the total groundwater discharge from the valley floor within the hydrographic basin. This value excludes groundwater discharge largely associated with springs in the uplands, and also excludes subsurface discharge out of Dry Valley. To the extent that subsurface outflow occurs at the Nevada-California state line and along structural conduits to other basins in Nevada, it is considered a source of water to the fully appropriated basins where it discharges and should not be double-counted.

IV. ORDER

NOW THEREFORE, IT IS HEREBY ORDERED, that the perennial yield of the Dry Valley Hydrographic Basin (095) is **1,100 acre-feet**.

ADAM SULLIVAN, P.E.
State Engineer

Dated at Carson City, Nevada this
9th day of August, 2022.